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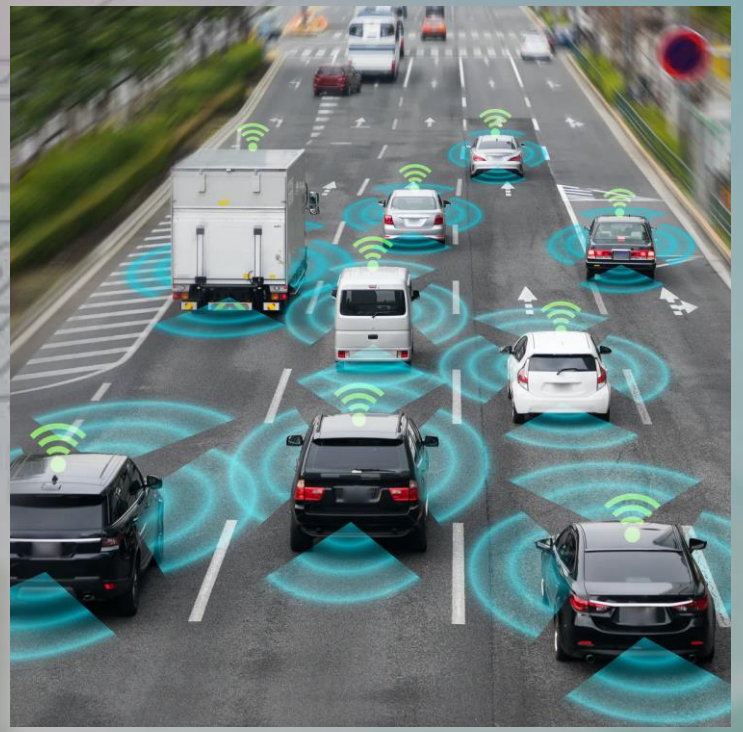

SAFETY AND SECURITY CHALLENGES FOR COOPERATIVE, CONNECTED AUTOMATED MOBILITY (CCAM)

FRANK BENDERS

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SAFETY AND SECURITY CHALLENGES FOR COOPERATIVE, CONNECTED AUTOMATED MOBILITY

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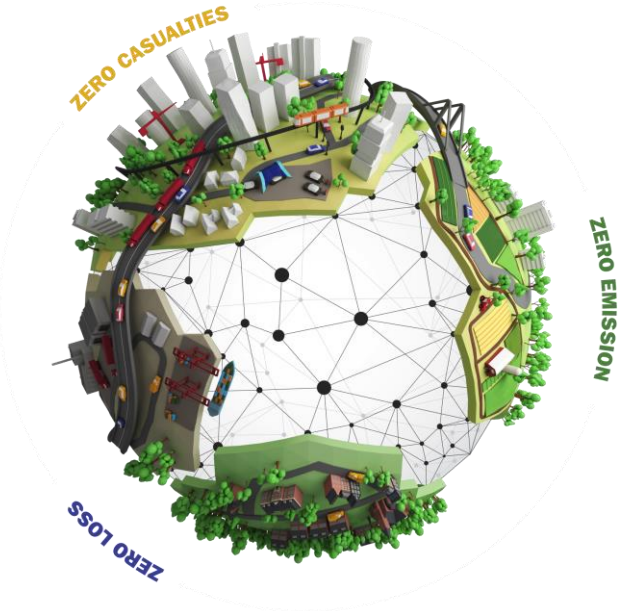
INTRODUCTION
GOAL IN AUTOMOTIVE



ZERO LOSS:

- Reduce the number of hazardous accidents
- This requires using complex cyber physical systems to avoid collisions

ZERO CAUSALITIES:

- Reduce the number of traffic jams and transport delays
- This requires using traffic information and advance automation using the cloud and maps and GNSS (GPS)

ZERO EMISSION:

- Use bio-fuels/electric suspension where need/possible
- Increase efficiency of transport flows
- This requires using GNSS and map data for smart charging and planning of fuel switching

INTRODUCTION
GROWING NEED FOR MOBILITY

CITIES

- Urbanisation → Growing population → Scarcity of space, healthy environment, energy

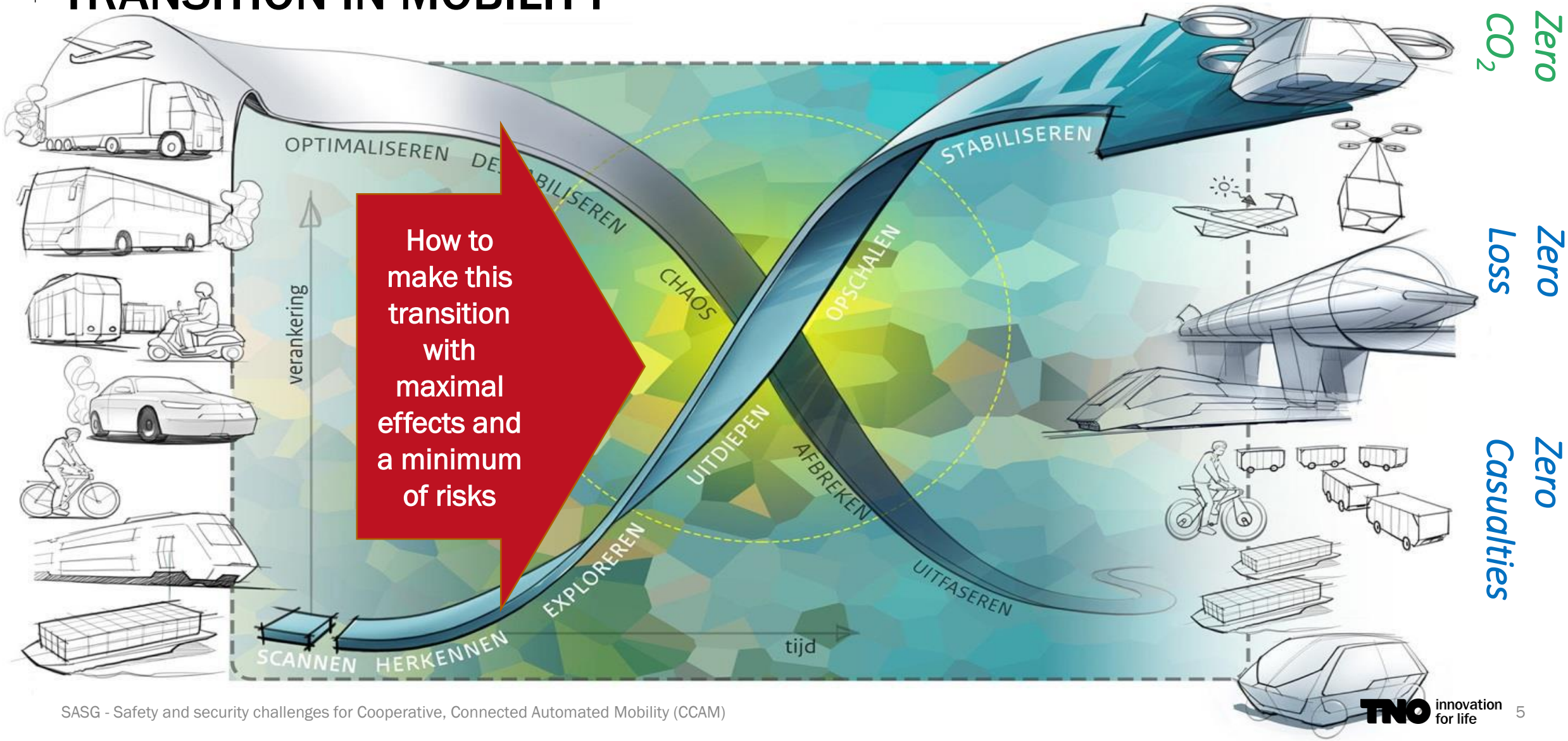
LOGISTIC HUBS

- Complexity → ICT, automated vehicles, and logistics & need for efficiency

CORRIDORS

- Globalisation and growing dependency on (digital) infrastructures → increased interoperability and standardisation

INTRODUCTION
TRANSITION IN MOBILITY



INTRODUCTION
COOPERATIVE, CONNECTED AUTOMATED MOBILITY

CCAM

- Possible solution for the complex dilemma

Challenge

We have a growing need for mobility and transport	We aim for Zero Casualties, Zero Emissions And Zero Loss

Example applications:

- Platooning
- Intelligent Speed Advice
- Road Works Warning
- Smart Intersection Crossing
- Green Light Optimisation Speed Advice (GLOSA)
- Infrastructure Supported Automated Driving

INTRODUCTION

TRENDS IN AUTOMOTIVE – CCAM

- **Development knowledge**: Combined System/Safety/Cybersecurity Engineering + Model Based Engineering
- **# Computers:** Hybrid computers ECU/CPU/GPU
- **Software**: Distributed multi-threaded software (millions lines of code)
- **Autonomy**: Transition to automated (SAE L3-L4) → Autonomous (SAE L5)
- **Networks**: Multi-layered network + including many smart gateways + Hybrid network and several Cloud/Fog
- **Sensors**: Many distributed/remote sensors
- **Redundancy**: Double/triple redundancy for safety and security reliability
- **Liability/Responsibility**: Vehicle Manufacture + Suppliers become responsible in case of casualties
- **Data storage**: Distributed and remote data storage
- **Privacy**: Private in vehicle/Cloud/Fog data – including data encryption
- **Update/maintenance**: Over the air updates and remote support/maintenance
- **Navigation**: Local/distributed/cloud based map information (High Resolution + sensor dependent map info)
- **Standardisation**: Increasing number of standardised message and protocols in automotive (WiFi-p / 5G)

TECHNOLOGIES
KEY ENABLERS

ENABLING TECHNOLOGIES

- Smart sensors
- Connectivity (Wifi-p, 5G/6G, etc.)
- Blockchain, advanced cryptography (including post-quantum cryptography)
- Digital platforms
- Artificial Intelligence
- Internet of Things (IoT)

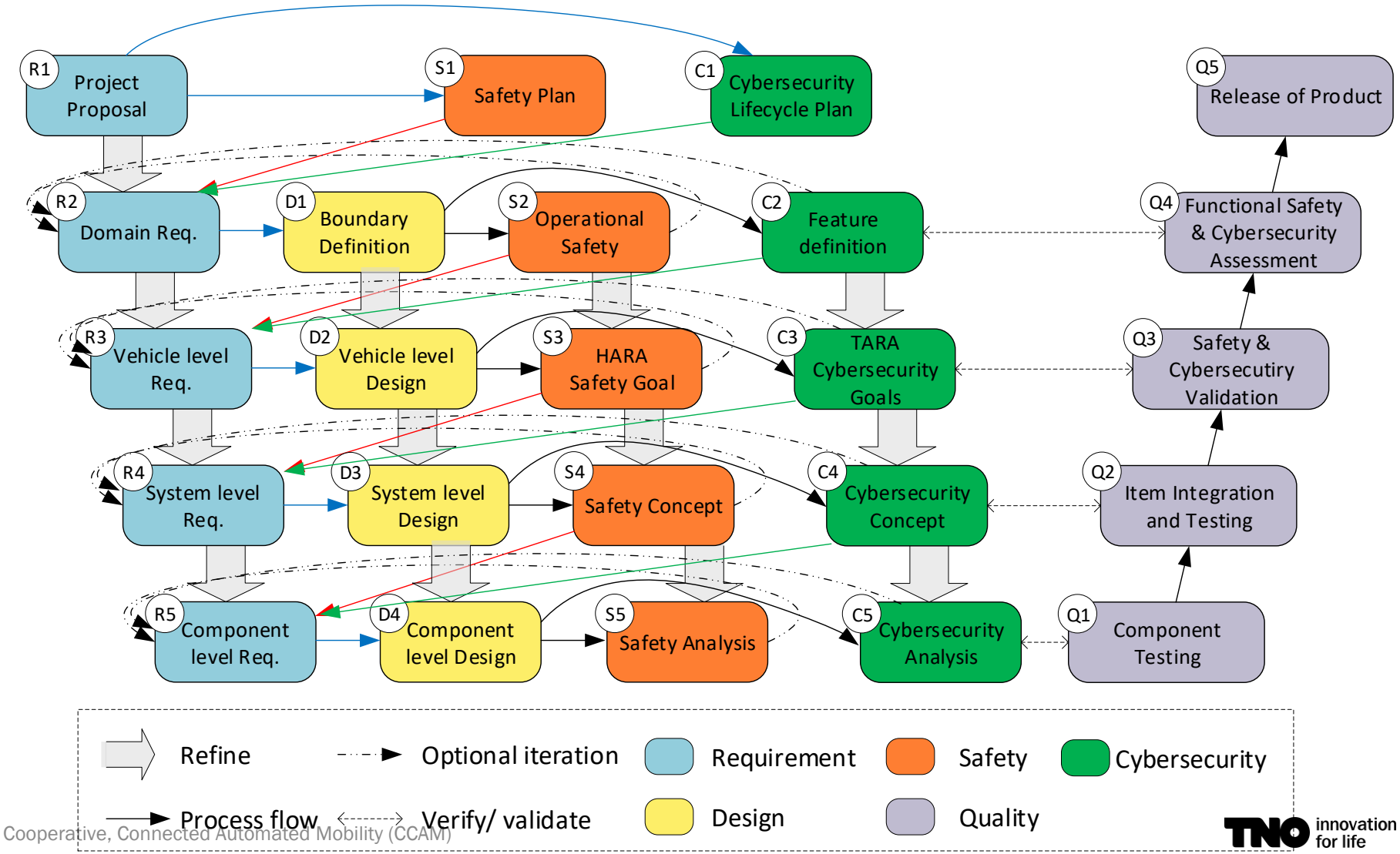
ENABLING METHODOLOGIES

- Integrated safety & security assessment methods
- Digital Twins
- Digital sovereignty
- Model-Based Systems Engineering

TECHNOLOGIES

SYSTEM DEVELOPMENT PROCESS

- V-cycle



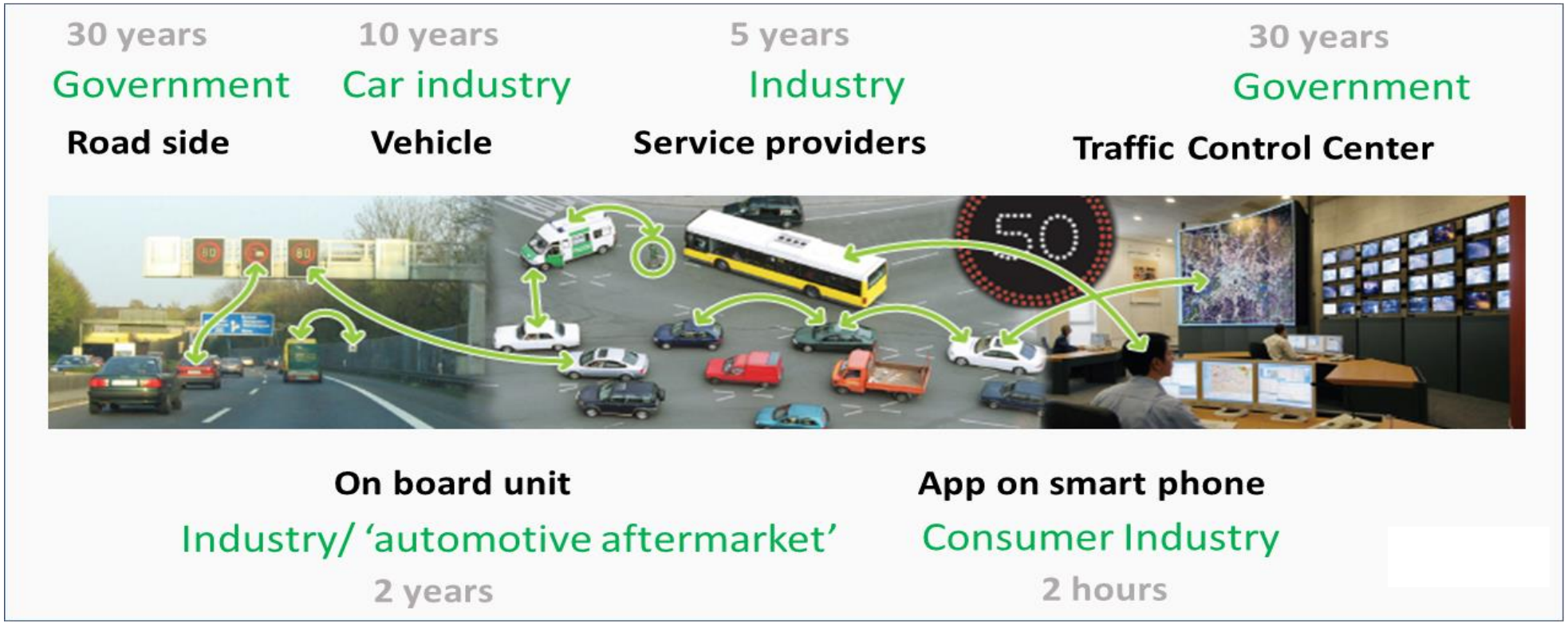
CHALLENGES – SAFETY RELATED
TOPICS

- Stakeholders
- Process
- Technical

CHALLENGES – SAFETY RELATED
MULTI-STAKEHOLDERS

- How to ensure safety for “conventional” and automated traffic?
- How to handle an up-to-date multi-stakeholder safety assurance?

- …many system components
- …with different owners,
- …and different life cycles



CHALLENGES – SAFETY RELATED
PROCESS

- Complex systems (or system-of-systems) require different development approaches
- Systems-of-systems are much more complicated to Verify & Validate (V&V) → certification & standardisation
  - Continuous integration/update & testing
  - Digital Twins for testing
  - Facilities for real-life testing (including generation of other traffic participants & infrastructure)
- Consistency and version management is crucial → life-time configuration management of system parts and continues (over-the-air) updates required
  - Approval/certification processes after updates should be standardised
  - Dependencies between components should be managed very accurately
- Trust in the shared information (from external parties) needs to be regulated
- Run-time monitoring becomes essential → black box recorders

CHALLENGES – SAFETY RELATED
TECHNICAL

- How to define/develop safe architectures that can be support during the whole life-cycle?
- Which run-time monitoring is required for assurance → black box recorders for which (extendable) data?
- How to make interface flexible but still reliable and safe?
- How to balance the conflicting requirements between functionality, safety, and security?
  - Use of more shared sensors data → higher performance, more safety challenges (dependencies), larger attack surface
  - Standardisation of protocols & interfaces → faster acceptance and interoperability, easier safety assessment, easier to attack and larger impact
  - Strict more reliable encryption → more latency and less performance, higher safety, better security

CHALLENGES – SECURITY RELATED
TOPICS

- Stakeholders
- Process
- Technical

CHALLENGES – CYBER SECURITY RELATED
STAKEHOLDERS

- How to get all stakeholders aligned?
- How to solve responsibility of stakeholders?
- How to solve General Data Protection Regulation (GDPR) issues (related to sharing privacy information)?

CHALLENGES – CYBER SECURITY RELATED
PROCESS

- How to regulate the trust in the shared information?
  - Multiple parties/stakeholders are involved in providing the data
  - Multiple parties/stakeholders need to support the security and protocols of communication channels
- How to create safe and secure software bug fixes/updates at a short notice to solve/mitigate the cyber attacks?
- How to ensure cyber security during the whole life-cycle (e.g. 15 years)?
  - Which organisational structure needs to created after the first official release?
  - How to support ethical hacking to find vulnerabilities?
  - How to share vulnerabilities?
  - What to do with vehicle/infrastructure that do not update after new releases?
- Which organisational structure is required to support the integrated (transdisciplinary) approach to develop safe & secure systems?
- How to regain trust after being attacked?

CHALLENGES – CYBER SECURITY RELATED
TECHNICAL

- How to detect attacks in the (local/global) networks?
- How to distinguish anomalies between faults and attacks?
- How to mitigate effects of attacks (robustness & resilience):
  - How to isolate the attack (where it is initiated)?
  - How to react → what is the safe state (e.g. automated parking along the road)?
  - How to safe and securely share attack information in the network (to limit the effects of the complete traffic flow)?
- Which (own and shared) data needs to be stored for analysing cyber attacks?
- Which post-quantum cryptography algorithms and protocols needs to be developed?
- How to make secure electronic components, interfaces, operating systems, firmware, communication, software and tooling?
- How to handle General Data Protection Regulation (GDPR) while attacks need to be analysed?

CONCLUSIONS
MANY CHALLENGES

TRUST

- Trust in the CCAM system-of-systems is crucial to get people to use and pay for these system

MULTIDISCIPLINARY AND TRANSDISCIPLINARY

- System-of-systems thinking is required to get these systems operational and keep them Safe & Secure

STANDARDISATION & REGULATION & POLICY

- Still many standards need to be developed and regulations needs to be approved to get the automated system to be approved by road authorities
- Harmonisation of validation methods are required
- Industry standards for architectures and infrastructure are required
- Life-time interoperability of system-of-systems and services is challenging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QUESTIONS?